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Bull management for cow/calf producers

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IT IS OFTEN SAID THAT A BULL CONTRIBUTES HALF THE production in a calf crop. This may be true for an average bull, but probably exaggerates contributions from a poor quality bull and dramatically underestimates those from a good bull. A good bull offers both high fertility and high genetic breeding value for one or more economically important characteristics, such as growth, calving ease, maternal value and carcass quality.

Fertility in a bull is generally defined as the ability to impregnate females. Certainly that is a minimum requirement, but a bull with high fertility is able to impregnate more than the expected number of cows in a short breeding season. Such a bull has greater economic value than one of lesser fertility (1,17). If the bull also has a desirable genetic background, it could contribute more than just half the production in a calf crop. Properly managing bulls from weaning through maturity will boost their contributions to herd productivity.

When selecting bull calves at or before weaning, breeders must carefully consider future genetic goals for the herd, and base their decisions on economically important characteristics. After bull calves are chosen, whether for retention as replacements or for eventual sale, their growth and well-being depend mainly on disease prevention and adequate nutrition.

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Disease prevention

Diseases affecting both young and mature bulls are essentially the same as those of breeding females. Do not assume that vaccinating one of these groups will also protect the other. Vaccinate both males and females.

Certain reproductive diseases (BVD and leptospirosis) can develop in the fetus while it is still in an infected female's uterus, resulting in offspring that become carriers of the disease. To prevent this carrier status of leptospirosis, vaccinate females at prebreeding and again at pregnancy testing. Vaccinate bulls at least annually for all five serovars (5-way lepto) of leptosprosis and for campylobacter (vibrio). In some cases, vaccinations may be needed twice a year. Occasionally, vaccinations for BVD and other viral diseases are recommended, but producers should consult their veterinarians for specific recommendations for diseases prevalent in their areas.

Buy bulls only from herds in which adequate disease-prevention measures are practiced, and administer booster vaccinations upon arrival at their destination. A one-month quarantine before placing with the remainder of the herd is advisable.

Controlling internal and external parasites is also important. Stomach worms and other internal parasites can reduce growth and performance; liver flukes may reduce fertility in bulls. External parasites reduce not only performance and overall health, but also eye appeal. A good hair coat free of lice, ticks and flies may be important when displaying bulls to potential buyers. Many products are available to control both internal and external parasites, and appropriate measures should be taken.

Nutrition

Adequate nutrition is vital, since it allows young bulls to more completely express genetic potential for growth, which predicts potential performance of eventual offspring. More important is that good nutrition also helps puberty begin on time, allowing for moderate breeding use by 15 to 17 months of age. Severe undernourishment may cause irreversible testicular damage in young bulls and decreased sperm production in mature bulls.

It is still argued as to whether weanling bulls should be fed for maximum gain on a full-feed performance test or for more moderate gain on forage. The former approach sometimes results in excess fatness, which can temporarily reduce breeding performance and sperm quality (3,4). The moderate-gain approach may avoid these problems, but precludes the chance for maximum gain. Breeders should refer to their association regarding specific test conditions.

Full-feed tests usually last 112 or 140 days, using diets designed to achieve potentially maximum gains. At as early as 7 to 9 months of age, bulls are slowly introduced to high-energy diets over a three- to four-week period, which prevents illnesses resulting from an abrupt change from a diet of milk and grass to one high in grain. Grain is added gradually to the ration until it supplies the desired level of nutrients and at that point, the official gain test begins. During this time, bulls are allowed either to eat ad libitum or be limit-fed about 3 percent of their body weight each day to maximize gain. When this approach is used with bulls of straight or percentage Brahman influence, rations should contain at least 20 percent roughage to avoid founder. Regardless of breed, full-feed rations should contain at least 10 percent roughage.

Specific ration design and ingredients for full-feed tests are not listed here because cost, availability and nutrient content of ingredients vary by year and region. However, rations should be designed according to National Research Council (5) standards for nutrient requirements in growing bulls. These requirements vary according to weight and desired rate of gain.

As the name implies, a forage performance test relies mostly on forages for nutrients. These tests usually last up to 10 months or longer, and for that reason may require both perennial and annual forages as the main part of the diet. When necessary, supplements are given to overcome nutrient shortages and reduced forage intake resulting from inclement weather. Clearly, average daily gains on forage performance tests are lower than that from full-feed tests, but over-fatness is avoided, reducing the potential for a temporary reduction in fertility. Nevertheless, when forage is adequate in growth and quality, some bulls can gain an average of 3 or more pounds a day.

Although full-feed tests are of shorter duration than forage tests, both cost about the same. Nevertheless, it is important to measure young bulls for growth using either type of test. This allows for growth rankings to indicate potential performance of offspring from each bull.

Mature bulls also need adequate nutrition. Severe underfeeding and poor grazing conditions that result in dramatic weight loss will lower sperm production and quality. Overfeeding can also reduce sperm quality (3,4). Since during the breeding period, bulls have access to the same diet as the cows, grazing and supplements that produce good body condition in females will also suffice for bulls. At a minimum, daily crude protein intake for mature bulls should be 7 to 8 percent (3 to 4 pounds of crude protein) for body maintenance and 10 percent or more for weight gain (5).

Monitor the bulls' body condition before breeding starts. If bulls are thin, begin supplementing to increase body fat. Do not feed to over-fatness, but to a level that gives them a smooth overall appearance. The ribs of adequately nourished bulls should not be visible. This equates to a body condition score of about 5.

Bulls also should have access to salt and a palatable mineral mix. Mineral mixes containing 6 to 12 percent phosphorus usually suffice. The lower percentage is appropriate when bulls are grazing well-fertilized pasture. The mineral mix's calcium content should range from 10 to 15 percent under normal grazing conditions or when moderate concentrate feeds are given.

Feeding cottonseed products

Cottonseed products have been used successfully for years as a concentrated source of protein in cattle rations. During the 1980s, concern arose over the use of cottonseed products in the diet of young bulls. The naturally occurring gossypol contained in cottonseed can temporarily reduce sperm quality in young bulls when fed at excessive levels for long periods. However, the severity of these problems varies because the toxicity effects of gossypol are influenced by cotton plant variety, cotton oil extraction procedures, diet content of cottonseed products and length of feeding period. Consequently, some degree of caution is warranted, but cottonseed products are completely safe in the diet of young bulls if these guidelines are followed (6):

- Whole cottonseed should be limited to 10 percent or less of a young bull's total diet (15 to 20 percent for mature bulls).
- Solvent-extracted cottonseed meal (a process used by 95 percent of Texas and Oklahoma cotton oil mills) should be limited to 5 percent or less of the total diet.
- Mechanically extracted cottonseed meal (used by less than 6 percent of Texas and Oklahoma mills) can be fed at a level of up to 15 percent of the total diet.

These recommended levels fall within the range of what typically has been fed over the years with no negative effects on reproductive performance. If the recommended levels of cottonseed products supply too little crude protein in the ration, add different protein sources (soybean, guar, fish, peanut, alfalfa, or other meals) to meet deficiencies.

Assessing fertility

Whether in young or mature bulls, a fertility assessment is required before breeding performance can be predicted. For a bull to impregnate females, the requirements are more complicated than expected. Bulls should, of course, be essentially disease-free and in overall good health.

They then must have enough libido to pursue, mount and serve an estrus female. This involves travel over short or long distances in varying terrain, requiring sound feet and legs. Copulation requires functional genitalia free of abnormalities. Finally, quality sperm must be deposited.

No single test can assess each characteristic described above, but a breeding soundness exam (BSE) should be the minimum test performed annually on all breeding-age bulls. Examinations should be conducted about 60 days before breeding season starts. This not only allows time to replace bulls if necessary, but also minimizes the time between examination and start of breeding. A BSE performed at the end of breeding can determine whether a bull has undergone any changes that may have compromised his expected performance during the breeding season. Veterinarians familiar with semen collection and evaluation can perform a BSE, which includes:

- Visual assessment of eyes, teeth, feet, legs and external genitalia;
- Internal palpation of accessory sex organs (seminal vesicles and prostate);
- Electroejaculation for semen sample collection and sperm evaluation;
- Scrotal measurement; and
- Physical exposure and examination of genitalia.

Figure 1. Measuring scrotal circumference.

Both functionality and longevity should be considered when evaluating bulls for structural correctness. The mouth, teeth and eyes are examined. Research has shown that good vision (7) is the most important sense a bull uses to detect estrus, though sense of smell may also contribute.

In observing genitalia, both testicles should be descended into the scrotum and be the same size. Swelling or other reasons for disproportionate size may indicate injury, illness or other testicular abnormalities. The testicles will also be palpated for texture. They should be well-formed but not hard.

Table 1. Scoring system and recommended scrotal circumference for bulls of various ages (except Brahman).

Age	Very good	Good	Poor
12-14 months	>34 cm	30-34 cm	<30 cm
15-20 months	>36 cm	31-36 cm	<31 cm
21-30 months	>38 cm	32-38 cm	<32 cm
over 30 months	>39 cm	34-39 cm	<34 cm

Adapted from the Society of Theriogenology

The scrotal circumference encompassing the middle of the paired testicles will be measured, one of the most important measures taken during a BSE (Figure 1). Because testicular size affects sperm quality, bulls with acceptable scrotal measures (Table 1) produce more sperm with a higher degree of sperm cell normality than do bulls with scrotal measures below accepted standards (8). Testicular size also affects the onset of puberty in bulls, with earlier puberty in those with large testes (9).

Puberty begins later in straightbred and crossbred Brahman breeds than in British and Continental breeds, partially because of smaller scrotal circumference. Therefore, it is important that producers of Brahman-influenced breeds select for increased scrotal circumference, which results in earlier puberty (Table 2). Furthermore, female offspring from bulls with large scrotal measures will reach sexual maturity sooner than daughters from bulls with scrotal measures below acceptable standards (10). Consequently, inadequate scrotal size in bulls has both short- and long-term negative effects on reproduction in a cow herd. Finally, since scrotal circumference is heritable, selection for increased scrotal size can improve reproductive performance (11). Some breeds report expected progeny differences (EPD) for scrotal circumference, and selection using scrotal circumference EPD is superior to simple phenotypic measures in reducing age at puberty in daughters (12).

Sheath character is important in Brahman-influenced bulls. Extremely pendulous sheaths (Figure 2) are undesirable, since they are more likely to be injured during

Table 2. Scoring system and recommended scrotal circumference for Brahman and Brahman crossbred bulls.

Age	Very good	Good	Poor
12 months	>22 cm	18-22 cm	<18 cm
13 months	>24 cm	20-24 cm	<20 cm
14 months	>26 cm	21-26 cm	<21 cm
15 months	>30 cm	26-30 cm	<26 cm
16-20 months	>31 cm	28-31 cm	<28 cm
21-24 months	>32 cm	29-32 cm	<29 cm
25-31 months	>35 cm	31-35 cm	<31 cm
Over 31 months	>39 cm	34-39 cm	<34 cm

Adapted from the Society of Theriogenology

travel and even during copulation. The incidence of sheath problems in Brahman and Brahman crossbred bulls is variable, but observations at slaughter indicate that about 10 percent of such bulls have pendulous sheaths, resulting in severe penile lesions. Clearly, sheath injury that also involves injury to the penis can interfere with breeding activity. Sheath character is heritable and can be altered through genetic selection (13).

Internal examination of the seminal vesicles and prostate may reveal swelling that could indicate infection or other abnormalities. Electroejaculation will provide semen samples. Semen evaluation consists of microscopic examination of sperm for motility, concentration and normality. During electroejaculation, the veterinarian exposes the penis for potential abnormalities. Both acquired and congenital abnormalities can interfere with, and even preclude, successful copulation. These conditions include warts, swelling, deviations, lacerations, penile hair rings and persistent penile frenulum. In young bulls nearing puberty, this procedure may reveal prepucial adhesions that are easily corrected.

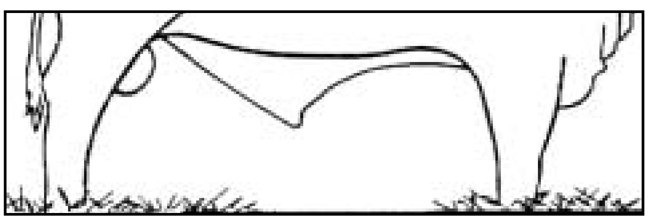
From the results, bulls are classed as satisfactory, unsatisfactory or deferred (indicating that the bull should be retested). Even though accurate, a BSE is nothing more than a snapshot of a bull's breeding potential at a particular time. Since a bull's physical condition and sperm production can change, a BSE should be conducted annually on all bulls before breeding season starts. Young bulls classified as deferred because of age will eventually mature and should improve in fertility. Such bulls should be tested again later to determine if improvements have occurred.

Libido and serving capacity

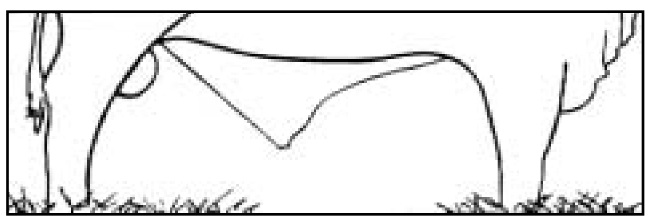
Quality semen, good health and vision and sound feet and legs are only part of the bull fertility picture. Libido and serving capacity are also important components. Libido is defined as sexual desire; serving capacity is the ability to complete the act of mating. Both these characteristics differ among bulls and are distinctly different components of fertility.

High libido is conducive to high fertility, but desire is only a precursor to successful mating. Consequently, some bulls with high libido cannot, for various reasons, successfully service a cow. In these instances, the usual culprits are lameness, inadequate erection or genital injury or abnormalities. If these conditions are temporary, the ability to mate successfully may return; but if permanent, such bulls should be culled. Other bulls may have little or no libido, obviously leading to low serving capacity.

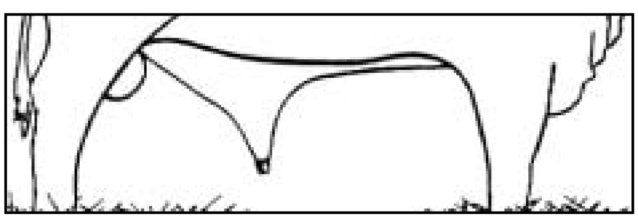
Unfortunately, libido and serving capacity do not correlate well to BSE test results. Bulls may possess quality semen,



Underline #l — acceptable



Underline #2 — slightly pendulous, risky



Underline #3 — very pendulous, unacceptable

Figure 2. Sheath characteristics in Brahman and Brahman crossbred bulls.

but may be unacceptable breeders because of lack of desire or mating ability. However, libido and serving capacity are influenced by genetic heritage (14) and vary among sires of the same breed. Apparently, a certain amount of the male hormone testosterone is involved, but higher levels of the hormone do not increase libido. Other variables such as degree of muscling, coarseness of hair and size of neck crest neither indicate nor predict the degree of libido or serving capacity (15).

Observing bulls during the breeding season for their ability to mate is good management, but tests have been developed to assess serving capacity in bulls. The first, a "pen" test (Figure 3), is recommended for Brahman-influenced bulls (16). Estrus females are penned with bulls at a female-to-male ratio of 1.5:1 or 2:1. Usually no more than eight females are penned with up to five bulls at one time. Two (preferably three) observers count sexual events, including mounts and completed services in a 30-minute period. Bulls achieving two or more services in the 30-minute period are considered high serving capacity. Bulls completing only one or no services are considered low serving capacity. The disadvantage of the pen test is that it requires estrus females. When many bulls are tested, females are given estrous synchronization treatments to ensure adequate numbers for the pen test.

Figure 3. A "pen" test is recommended for Brahman-influenced bulls.

The second method of measuring serving capacity can be used on British and Continental bulls and involves stanchioned females, either estrus or not. Female-to-male ratio is 1:1. Bulls achieving more than three services in a 20- to 30-minute period are considered high serving capacity, while those achieving two or three are moderate. Bulls achieving one or no services are classed as low. The advantage to stanchion tests is that fewer females, either estrus or not, are required.

The degree of serving capacity is important. Research has shown that high-serving-capacity bulls, compared to low bulls, impregnate more females and in fewer days. This translates into higher production through more pounds of calf. In two trials (1,17), high-serving-capacity bulls increased pounds of calf weaned per cow by an additional 60 to 98 pounds compared to that of low-serving-capacity bulls. Since serving capacity is heritable, selection for increased serving capacity can increase reproductive performance.

Young bulls without breeding experience occasionally show low serving capacity when first tested, and an accurate assessment may require at least two tests given three to ten days apart. Mature bulls usually can be measured accurately with only one test.

Heparin-binding protein

Before 1990, quality semen was generally characterized as containing high numbers of live, normal sperm cells, but efforts soon followed to determine why there was such a dramatic difference in fertility among bulls with similar sperm quality.

Research revealed (18) that a protein produced from the prostate, seminal vesicles and Cowper's gland was released into the semen at ejaculation. This protein, referred to as heparin-binding protein, contains a particular chemical fraction known as fertility associated antigen (FAA), which attaches to the sperm cell membrane. Once attached, FAA then binds sperm cells to "heparin-like" compounds in the female reproductive tract. This binding action is needed to initiate a 6- to 8-hour-long process known as capacitation, and until the process is complete, sperm cells cannot fertilize an egg.

Further research showed that the degree of FAA attachment to sperm varies greatly among bulls, suggesting a reason why fertility differs so much among bulls that, because they passed a breeding soundness exam, would otherwise be expected to be highly fertile. Breeding challenges using bulls differing in degree of FAA binding have been conducted. All bulls in these trials passed a breeding soundness exam and their semen was analyzed for the FAA fraction. Based on FAA analysis, the bulls were classed as either having the fraction bound to sperm or not. Data from natural breeding (2,19) on about 6,000 cows showed pregnancy rates averaging 81 percent in cows mated to bulls with FAA on their sperm compared to 63 percent in cows mated to bulls without FAA on sperm.

Another natural mating trial (17) involving 650 cows showed that bulls with FAA on sperm generated an additional 50 pounds of calf per cow because of higher pregnancy rates and earlier conception dates compared to cows mated to bulls without FAA on sperm. Bulls without FAA on sperm are neither sterile nor highly fertile, but somewhere between.

Initial research on this subject determined that FAA status for any bull remains constant, so fertility in bulls without FAA on sperm cannot improve dramatically. Except possibly for injury, illness or temporary heat stress in summer, fertility in bulls with FAA on sperm is unlikely to decrease.

Other trials using frozen semen in artificial insemination revealed that non-lactating cows inseminated to bulls with FAA on sperm required fewer services per conception (20). In estrous-synchronized heifers (263 head), percent conception to time mating using semen from bulls with FAA on sperm was almost twice as high as when using semen from bulls without FAA on sperm.

Testing bulls for FAA can improve herd fertility. The Repro Test® is commercially available, "chute-side" test kit (21) that can easily be included with a routine breeding soundness examination, improving the accuracy of that procedure. A drop of fresh semen is placed on a lateral flow cassette. A color change indicates an FAA positive bull and results are available in 10 to 20 minutes. A single test is good for the life of a bull, but the Repro Test® is not recommended for frozen semen intended for AI. Extenders that are added during semen processing can cause interference with test antibodies. Still, AI sires can be tested using fresh, unextended, unfrozen semen.

Breeding pressure and usage

Typically, a bull-to-cow ratio of 1:25 is recommended. This ratio is normally adequate, but research shows that it can be wasteful, particularly for highly fertile bulls and in situations where bulls do not have to travel long distances to find cows.

In one trial, six single-sire mating herds with a bull-to-cow ratio of 1:50 were chosen for a 60-day breeding season. The bulls were 2 years old, and all females were cyclic and showing estrus. The only factor affecting pregnancy was serving capacity (1). Bulls with high serving capacity settled 83 percent of the females, while low-serving-capacity bulls settled 67 percent. This suggests that bulls with high serving capacity can withstand heavier breeding pressure than bulls with low serving capacity. Because of higher pregnancy rates and earlier conception in females mated to high-serving-capacity bulls, an additional $53 gross income per female was generated compared to females mated to low bulls. This suggests the importance of choosing bull-to-cow ratios that allow high-serving-capacity bulls to be used over a larger number of cows. Ratios of at least 1:40 for such bulls would be appropriate. Such a practice truly allows high-serving-capacity bulls to contribute more than just half the production in a calf crop.

Many producers run mature and young bulls (less than 4 years old) together in the same breeding pasture. This may not be a good practice, since mature bulls are generally dominant, giving younger bulls little or no chance to breed. If these young bulls are particularly valuable because of their genetic background, much of their contribution to production is clearly prevented. It is best to separate bulls less than 4 years of age from older bulls and use them in at least two separate breeding pastures. This also reduces chances of injury from fighting that occurs when the two age groups are combined.

In multiple-sire pastures, dominant bulls may have access to more females than submissive bulls do. This is probably acceptable if the dominant bulls are indeed fertile, but dominant bulls with low semen quality or low serving capacity clearly impede good reproduction. Producers should remember that bull fertility has many components, making a complete fertility assessment fairly complex.

A bull's degree of dominance may also be influenced by its weight. It may be beneficial to separate bulls by weight, but separation by age is likely to circumvent any dominance associated with size.

To reduce an assumed level of excess breeding pressure on bulls, producers occasionally rotate bulls in and out of the breeding pasture at frequent intervals, typically every 14 to 21 days. The amount of breeding pressure that bulls can tolerate is unknown, but trials show (1) that bulls can withstand more pressure than is usually expected. Furthermore, frequent ejaculation does not reduce sperm quality or numbers (22), and fertility remains acceptable even under heavy pressure.

Perhaps the biggest problem arising from rotation is that producers can unknowingly remove their most fertile bulls from the pasture at a time they are needed most. Replacing them with a potentially less fertile bull can lower pregnancy rates. In practice, rotation is effective only when the serving capacity for each bull is known. Bulls with high serving capacity should remain with the herd, while low bulls can be rotated or, better yet, culled.

Purchased bulls should be procured from an area environmentally similar to their eventual destination. Bulls reared in dry, cool climates may require months of adaptation if moved to warmer, more humid climates. This period of adaptation is often accompanied by a drop in fertility. In some instances, this decrease is dramatic and may last several months.

Considerations for culling

Bulls are most often culled for old age, which is appropriate because semen quality declines after age 6 (23). It is also at this age that mature bulls begin to lose their social dominance rank to younger, more aggressive bulls and have fewer chances at breeding. Especially valuable aged bulls (more than 7 years) should probably be used in single-sire matings, but a drop in fertility should be expected because of age.

Clearly, bulls should be culled for poor vision, lack of desirable conformation, low quality semen and inadequate serving capacity. It may also be important to cull for poor disposition, simply from the standpoint of safety and prevention of injury to other animals.

From a genetic perspective, bulls that produce low-performing offspring should be culled. Take steps to prevent sires from mating their close relatives to avoid in-breeding if it is deemed undesirable. On the other hand, genetically superior sires are often retained past 7 years of age, but usually for very specific matings in purebred operations or in situations where heifers are not retained as replacements.

Summary

The following management techniques are recommended to ensure that bulls are given the best opportunity to contribute their fullest production potential and to reduce the chances of low fertility:

- Use bulls with acceptable genetic potential for economically important traits such as growth, carcass quality, maternal value and calving ease.
- Control disease with appropriate vaccinations (consult a veterinarian).
- Provide adequate nutrition from weaning age through maturity. Undernourished bulls are likely to have low fertility.
- An annual breeding soundness exam (BSE) should be conducted on all breeding-age bulls about six to eight weeks before the start of breeding. Do not use bulls that fail a BSE.
- Avoid bulls with small scrotal circumferences and extremely pendulous sheaths.
- Have bulls tested at least once for their fertility associated antigen (FAA) profile. Highest fertility can be expected from bulls with FAA on sperm.
- Observe bulls throughout breeding for their ability to mate. Perform serving-capacity tests when feasible. Bulls with low serving capacity settle fewer cows than high-serving-capacity bulls.
- Use separate breeding pastures for bulls less than 4 years old. Running them with older bulls may cause dominance problems, affording fewer chances for young bulls to mate.
- Cull bulls with poor vision, low semen quality, lack of desirable conformation and those producing inferior calves.

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